2017 Design Training Expo

Innovative Intersection Lighting Design For Pedestrians

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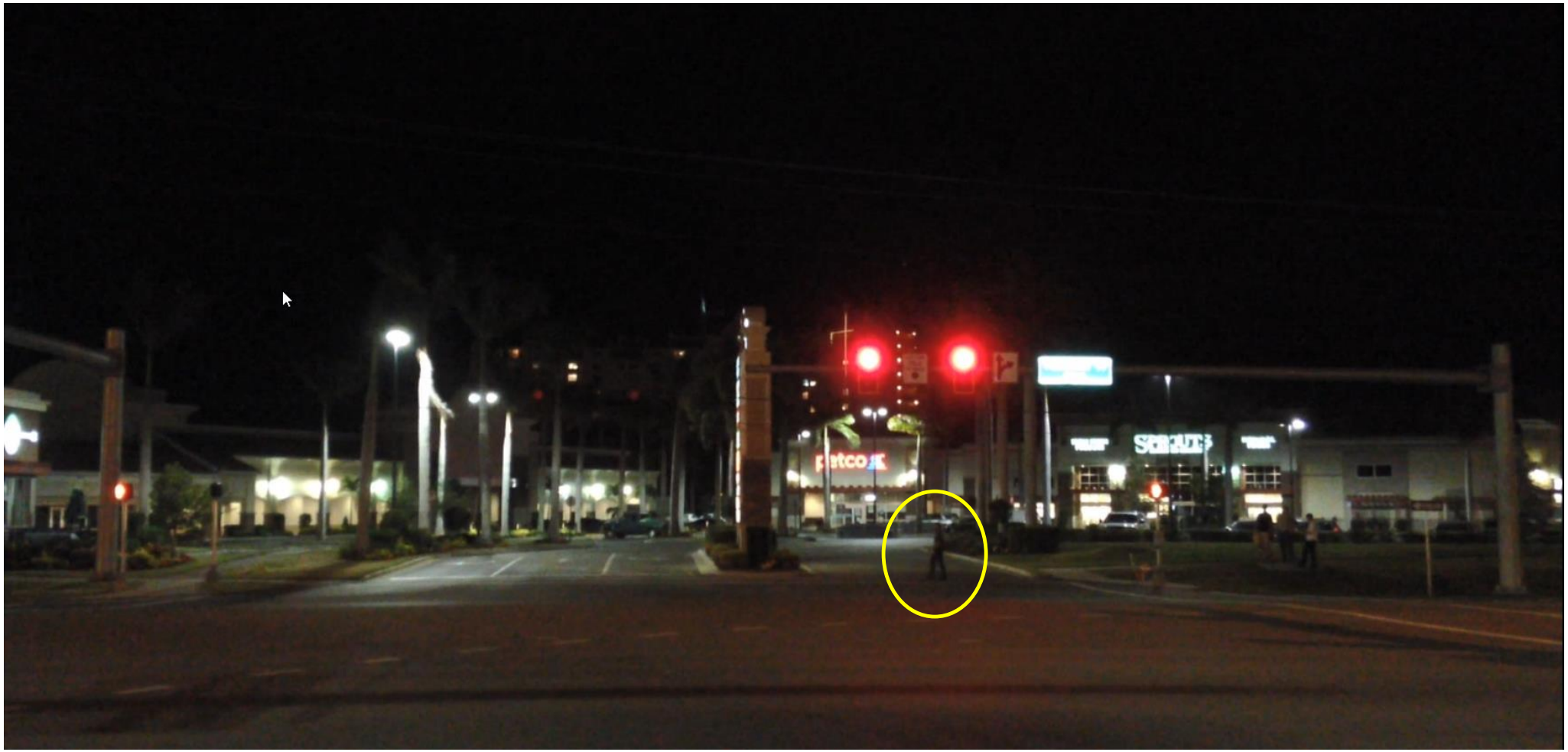
Problem - Pedestrian Crashes at Night

- Causes:
  - No street lighting
  - Insufficient lighting at signalized intersections
  - No sources of ambient lighting
  - Pedestrians not crossing at appropriate locations
  - Driver distractions
- Potential Solutions:
  - New conventional street lighting
  - Add or retrofit existing street lighting at signalized intersection

Problem – Poor Crosswalk Lighting



Bright Idea!

SOLUTION:

- Add a LED fixture to the mast arm to light the crosswalks.

CHALLENGES:

- What fixtures do you use and is it on the APL?
- How do you mount the fixture?
- Will the mast arm support the load?
- Mast arm location vs. crosswalk location.
- Is it possible to adapt statewide?
- What are the impacts to drivers?

Ultimate Goals

- Increase pedestrian visibility at night in crosswalks
- Reduce nighttime crashes
- Additional option for analysis
  - **Light the un-lightable**
- Provide a supplement for conventional lighting
- Create a cost-effective solution

Keep An Open Mind!

- We are currently studying the feasibility and application of this idea.
- Not currently approved to be used statewide.
- Products used in the study are not on the Approved Products List (APL)

Lighting Analysis

New Signalized Intersection Lighting Criteria

- Horizontal Illumination – 3.0 foot-candles
- Vertical Illumination – 2.3 foot-candles
  - Driver's view of pedestrian in crosswalk
    - Thru – near side
    - LT/RT – far side

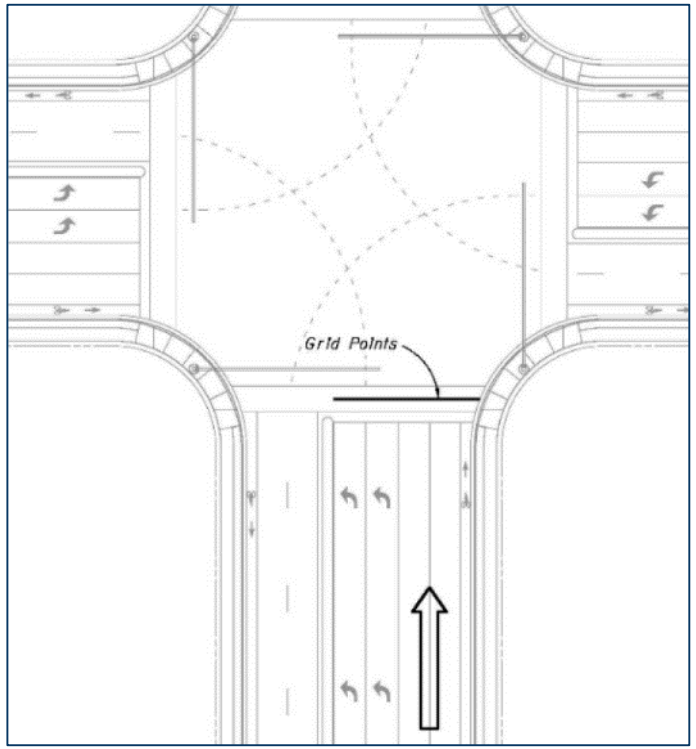
Table 7.3.3 Signalized Intersection Lighting
Urban 3 to Urban 5 Designated Areas*

ROADWAY CLASSIFICATIONS	ILLUMINATION LEVEL AVERAGE INITIAL FOOT CANDLE		ILLUMINATION UNIFORMITY RATIOS		VEILING LUMINANCE RATIO
			AVG./MIN.	MAX./MIN.	Lv(max)/Lavg
MAJOR ARTERIALS	Horizontal (H.F.C.)	3.0	4:1 or Less	10:1 or Less	0.3:1 or Less
	Vertical (V.F.C.)	2.3**	N.A.	N.A.	N.A.

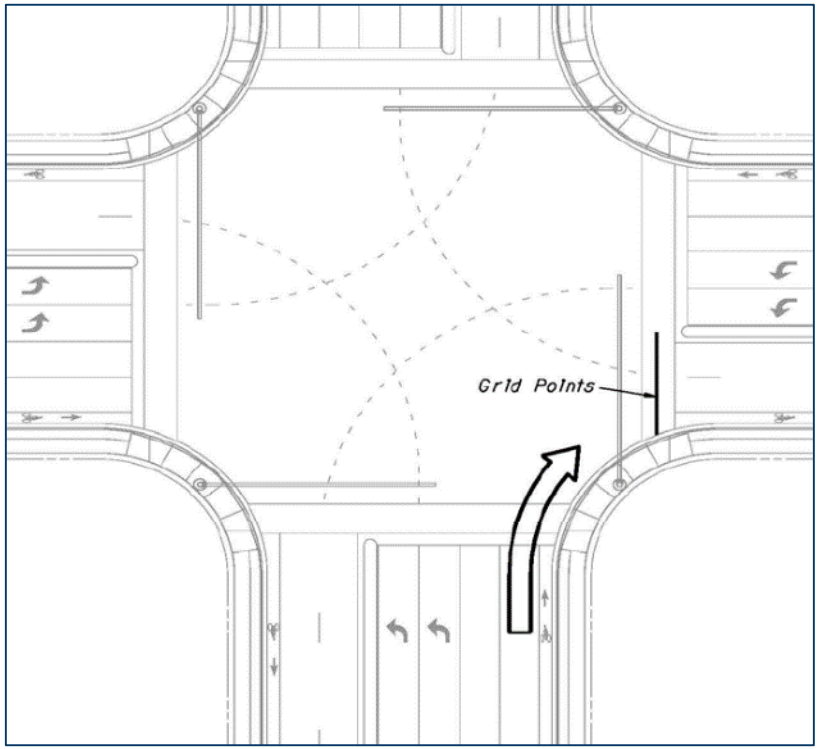
Notes: * Urban 3 to Urban 5 Designated Area are defined in the ***RCI Features & Characteristics Handbook,*** *Urban Classification – Feature 124, Urban Size*

** Vertical illumination value is only valid for new projects or where the intersection is being reconstructed. The vertical illumination is a target value and may not be achievable for all traffic movements.

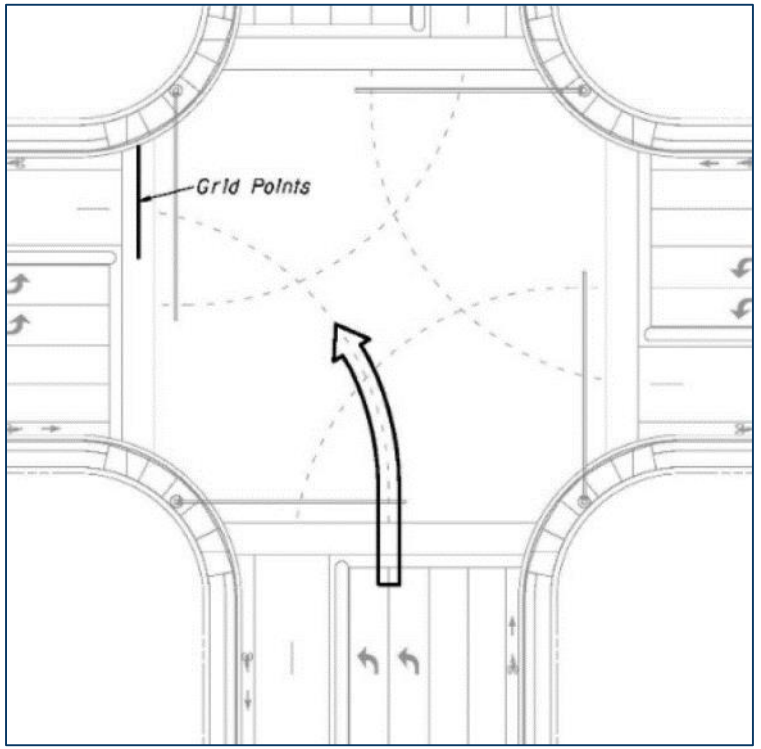
Vertical Illumination – Turning Movements



Near-side Thru



Right Turn

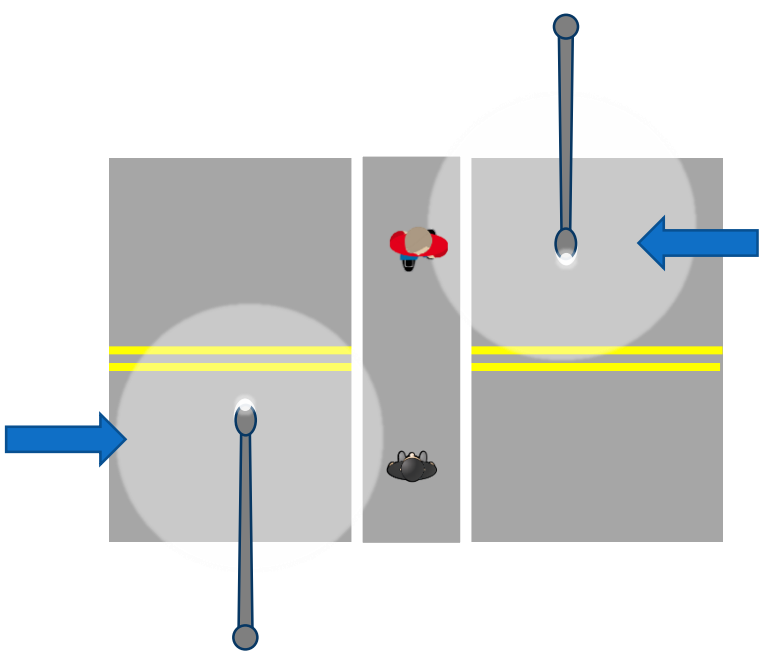


Left Turn

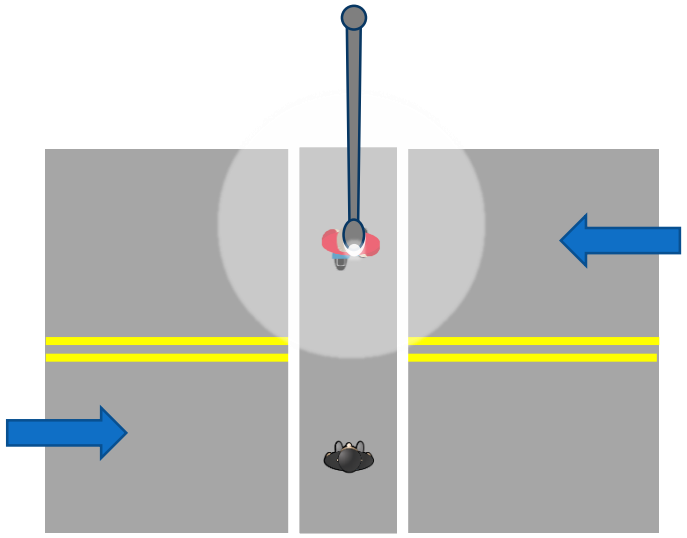
Source: FDOT Plans Preparation Manual, 2017

Vertical Illumination - Design

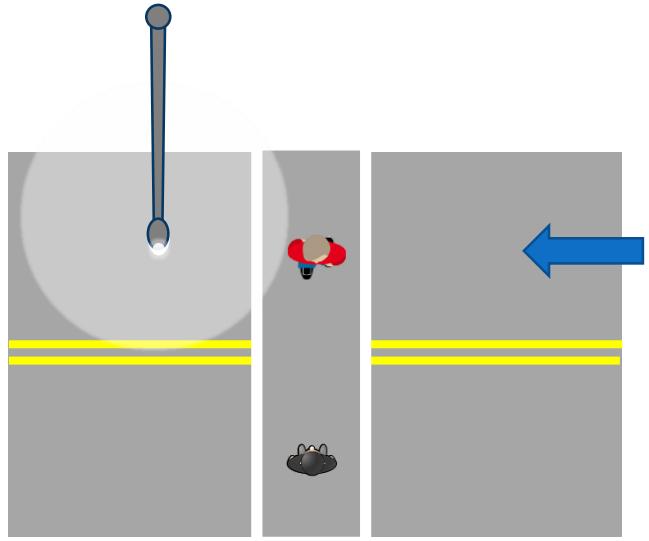
- Luminaire Placement
  - Mast Arm vs Crosswalk Location



New Crosswalk Lighting Design



Old Crosswalk Lighting Design

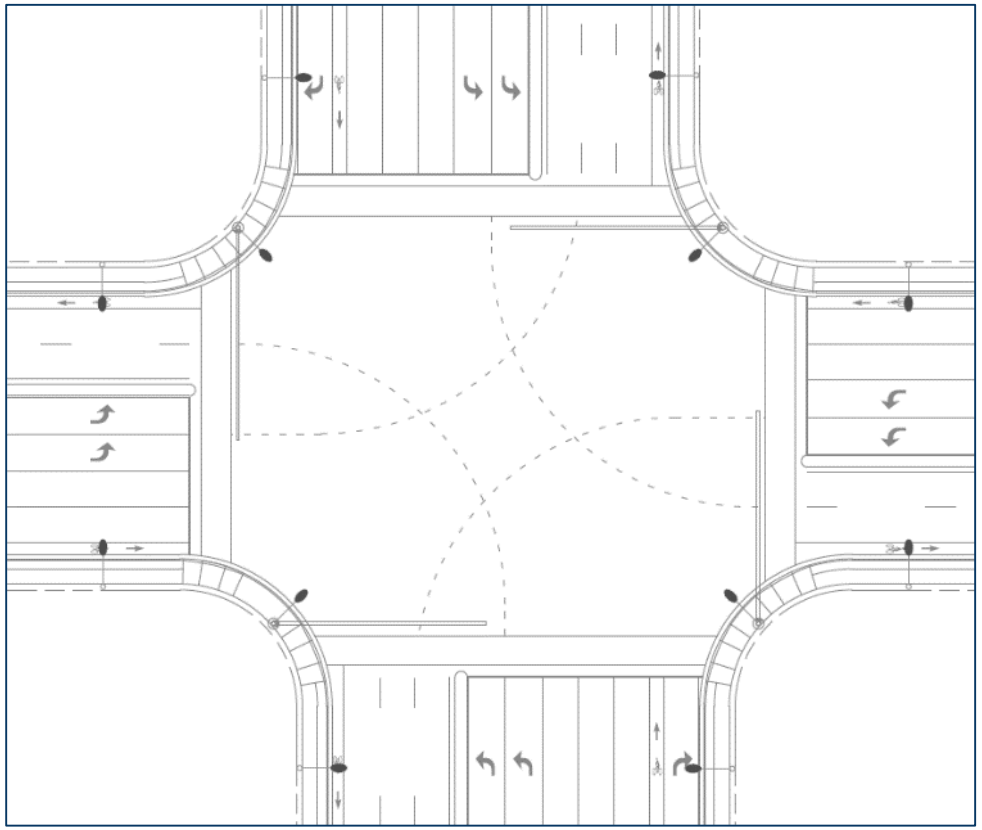


Typical Existing
Mast Arm Layout

Vertical Illumination – Lighting Layout

PPM Layout - 12 Light Poles

- Design Constraints
  - Utilities – Above/Below Ground
  - Right of Way
- Cost
  - Roughly $6,000 per Light Pole



PPM Figure 7.3.4: Typical Lighting Layout for Large Intersection

Source: FDOT Plans Preparation Manual, 2017

Research & Development

- Light Bars
  - Poor Roadway Photometrics
  - Didn't Meet Spec
  - Mounting Issues

Manufacturer	Model	Picture	Price	Lumens	Watts	Size (L/W/H) (in)	Weight (lbs)	APL?	Meet Spec? IP66[1] 4000K[2]
Rough Country	CREE LED Light Bar		$ 310.00	23,000	288	50 x 3 x 4	N/A	NO	?
Super Bright LEDs	HBL Linear Series		$ 400.00	16,000	150	5 x 47 x 4		NO	NO IP65[1] 5000K[2]
CREE	EDGE Transportation		$ 918.00	5,000 - 28,000	46 - 263	18 x 12 x 9 18 x 21 x 9	34 - 55	NO*	YES YES
Visionaire	Bow			4,000 - 16,000	38 - 140	30 x 6 x 4 47 x 6 x 4	18 - 22	NO*	YES YES
GE	Albeo Linear		$ 370.00	3,300 - 14,800	23 - 117	51 x 7 x 5 98 x 7 x 5	8 - 19	NO*	NO IP65[1]
Ecosense	TROV L50		$ 850.00	901/LF	12/LF	2.4 x 2.4 x 12	2 lb / 1' 10 lb / 4'	NO	YES YES

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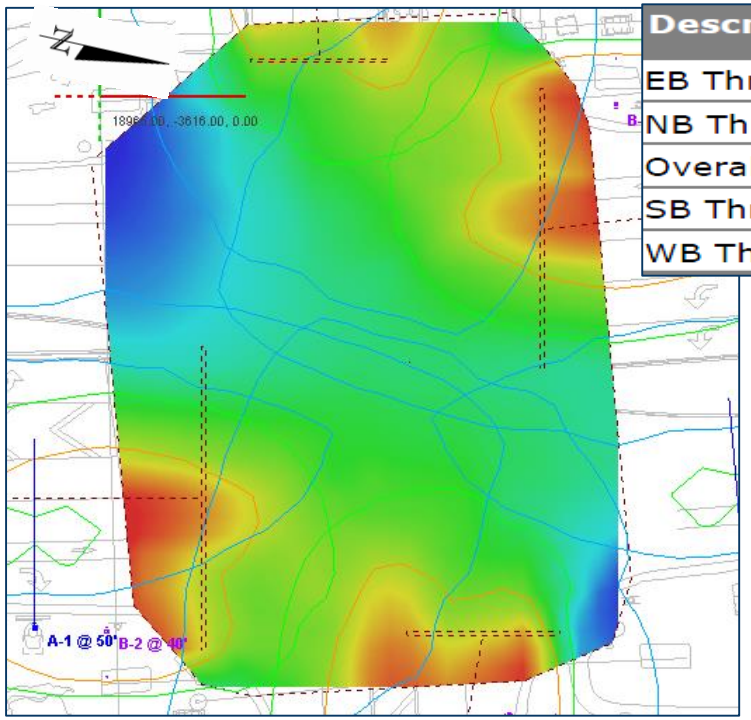
Research & Development

- Standard Fixtures
  - APL Manufacturers for Smaller Versions of APL Fixtures
    - 20 lb vs 40+ lb APL Fixture
    - Type II, III, IV Distributions
    - Scalable Lumen Output

Manufacturer	Model	Picture	Price	Lumens	Lumens in Analysis	Watts	Size (L/W/H) (in)	Effective Projected Area	Weight (lbs)
GE	LED Area Light N Series EANB		$625	4000 - 13,000	6200	58	14 x 16 x 4	0.43 ft^2	19
GE	LED Roadway ERL1		$300	4000 - 13,000	5800	53	22 x 13 x 4	0.5 ft^2	15
American Electric Lighting (AEL)	ATBM		$350	7000 - 17000	7000	60	28 x 13 x 4	0.3 ft^2	21
American Electric Lighting (AEL)	ATB0		$350	5000 - 15000	5500	48	27 x 8 x 4	0.76 ft^2	14

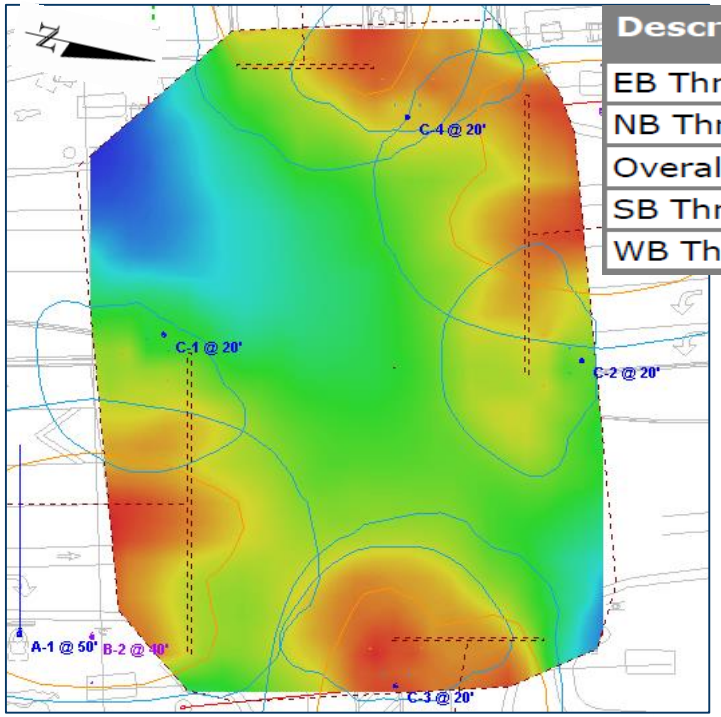
Research & Development

- Analysis
  - Before: Standard 40’ Shoulder Mount – 1 per Approach
  - After: Standard 40’ Poles + 4-20’ Mast Arm Mounted Fixtures



Description	Avg
EB Thru	2.3 fc
NB Thru	1.8 fc
Overall	2.0 fc
SB Thru	1.7 fc
WB Thru	1.8 fc

Before



Description	Avg
EB Thru	2.3 fc
NB Thru	2.4 fc
Overall	4.1 fc
SB Thru	2.9 fc
WB Thru	4.2 fc

After

Initial Concept

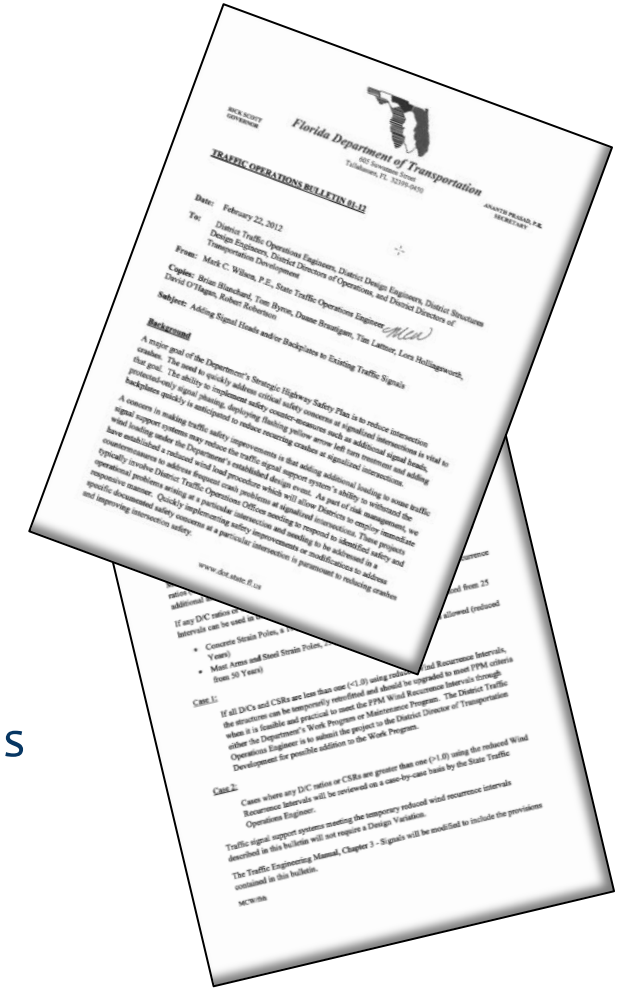
Structural Review

Structural Review

- Why does it need to be reviewed?
  - Ensure public safety
    - Ensures light does not rotate into the travel path
  - Identify if mounting a lighting fixture to the mast arm is feasible
  - Evaluate structural integrity of the complete mast-arm assembly
    - Includes arm, upright and foundation elements
    - Ensure the existing structure is not overstressed
  - Understand allowable variance
    - Weight, available wind area, future mast-arm mounted elements, etc.

Structural Review

- What was reviewed? – District One Structures Design Office
  - Combined Stress Ratios (CSR) for mast arms, uprights, and anchor bolts
  - Proposed Wind Loading
    - Case 1:
      - 170 mph for Sarasota County per 2017 Structures Design Guide (SDG)
    - Case 2:
      - Reduced Wind Recurrence Intervals per Traffic Operations Bulletin 01-12
  - Structural integrity of mast arms
  - Existing plans and shop drawings
  - Light fixture and bracket connection to mast arm, including resistance to rotation
  - Environmental Impacts


Florida Department of Transportation

TRAFFIC OPERATIONS BULLETIN 01-12

Image: FDOT.gov
http://www.fdot.gov/traffic/doc_library/PDF/Memos/traffic%20ops%20bulletin%2001-12%20traffic%20signal%20loading.pdf

Structural Review

- How we decided on the placement & bracket
  - Pedestrian lighting placement need
  - Optimal placement for meeting Standards
  - Safety of the traveling public
  - Mast-arm assembly stress ratio limits based on applied wind loading
  - Rotation resistance capacity of the bracket
  - Potential driver impacts

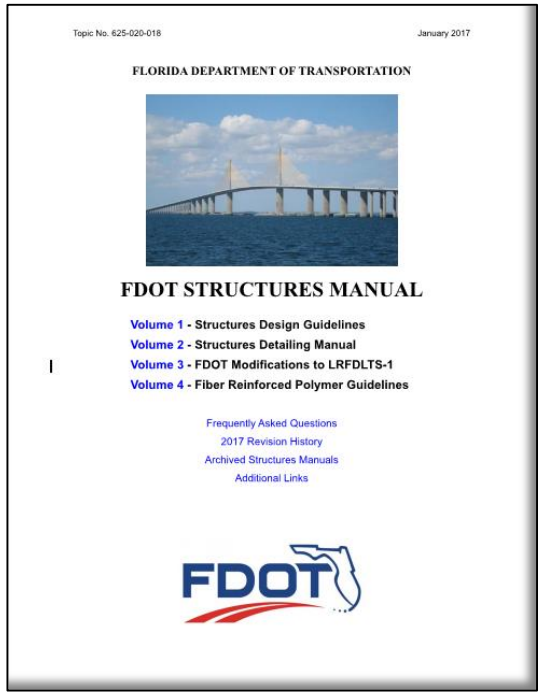
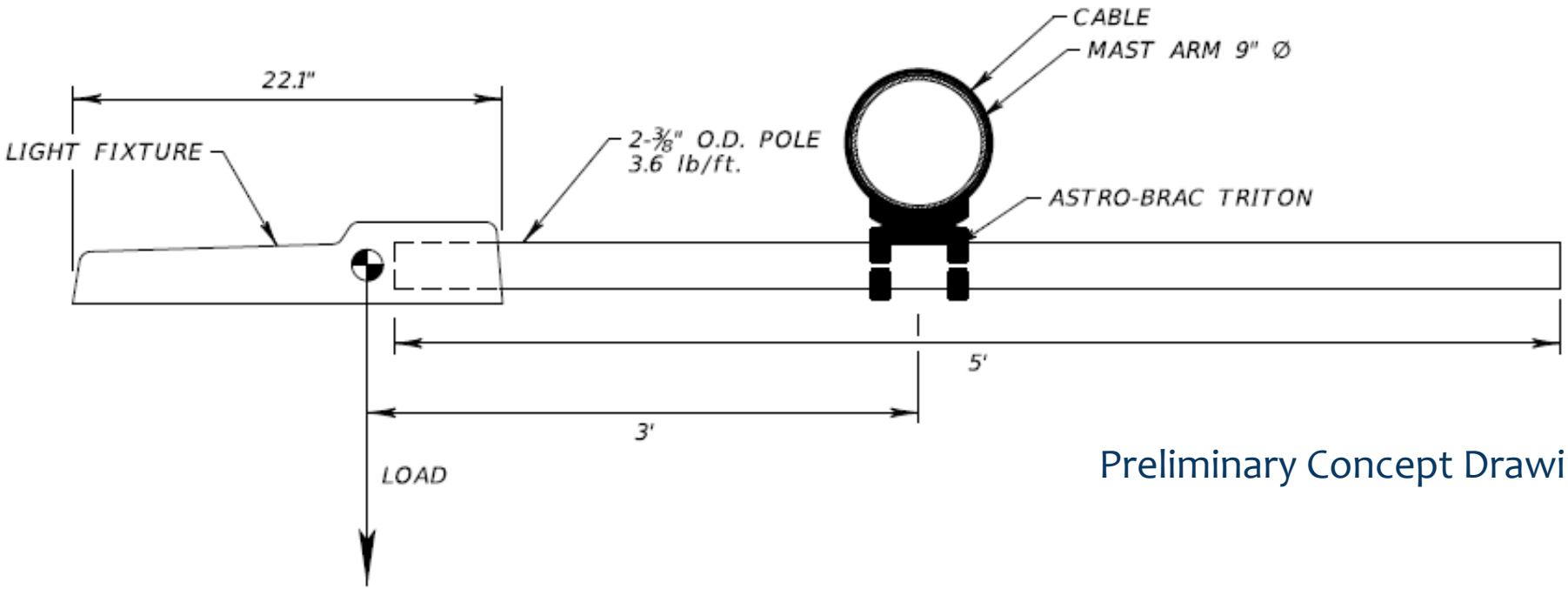


Image: FDOT.gov
http://www.fdot.gov/structures/StructuresManual/CurrentRelease/StructuresManualIntroduction.pdf

- Calculations
  - Ensure that the bracket and bracket arm could withstand anticipated loading
  - Ensure that the existing structure could support the proposed loads from the light fixture, bracket, and bracket arm

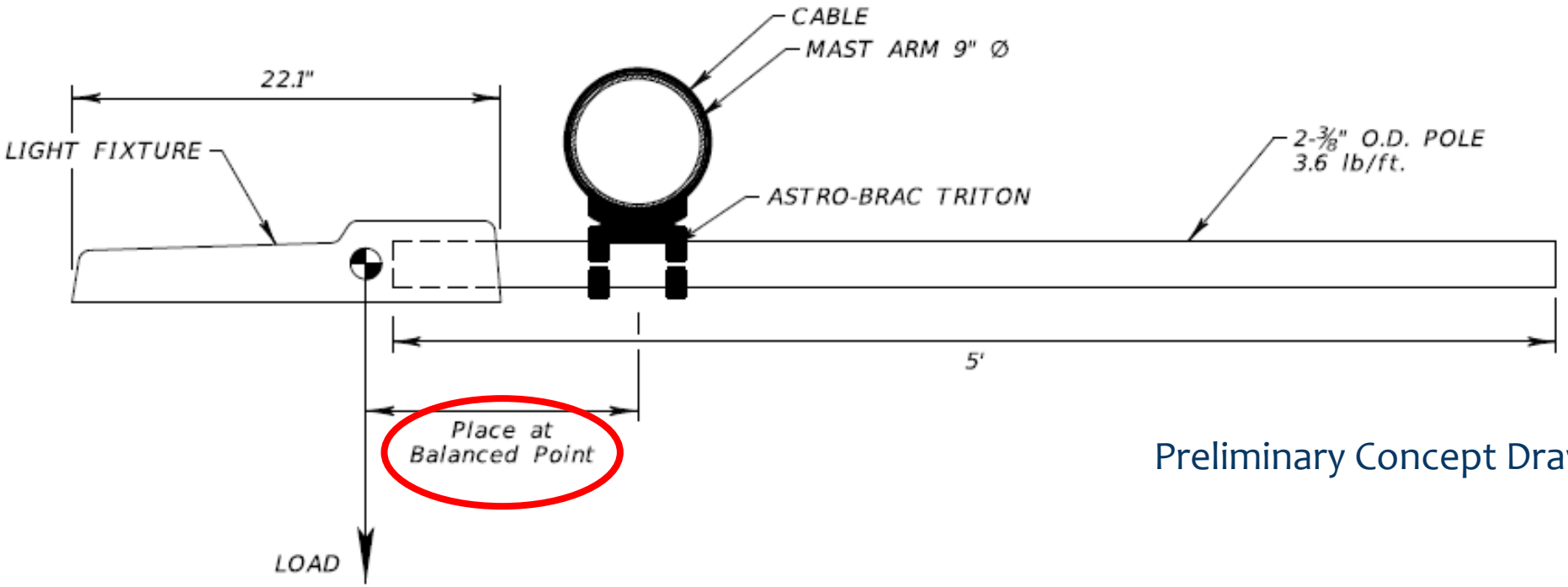
Structural Concerns



Preliminary Concept Drawing

Will the fixture rotate?
No, the Bracket has a minimum rotational resistance of 600 ft/lbs
(based on a 4" mast arm diameter)

Structural Concerns



Preliminary Concept Drawing

Will the fixture rotate?
No, the Bracket has a minimum rotational resistance of 600 ft/lbs
(based on a 4" mast arm diameter)

Fitting the pieces together

Fitting the pieces together – Light Fixtures

GE Evolve LED Roadway Lighting

ERL1 - Cobrahead

(15.5 lbs, EPA 0.5 sq.-ft.)

Image: http://www.estudiosdeiluminacion.com/wp-content/uploads/2015/05/OLP3093-GE-LED-Evolve-Low-Wattage-Street-Light-ERL1-Data-Sheet_tcm201-919591-e1432856054275.bmp

GE Evolve LED Roadway Lighting

EANB – Area Light

(19.0 lbs, EPA 0.43 sq.-ft.)

Image: GE Lighting http://www.gelighting.com/LightingWeb/na/images/GE-Evolve-LED-Area-Light-EANA-MG6466-855x600_tcm201-88615.jpg

Fitting the pieces together – Pipe and Bracket

Pipe

Galvanized Steel
Dia. = 2- 3/8” O.D.
Tk. = 1/8” Min.
Length = 5’ (3.6 lb./ft.)

Image: tasnimnews.com
https://tse4.mm.bing.net/th?id=OIP.s1ubXYrgWw6eIFeW6F9CBgEsDQ&w=291&h=202&c=7&qlt=90&o=4&pid=1.7

Mast Arm Bracket

3-Cable (separate, adjustable)
Dia. =2- 3/8” O.D.

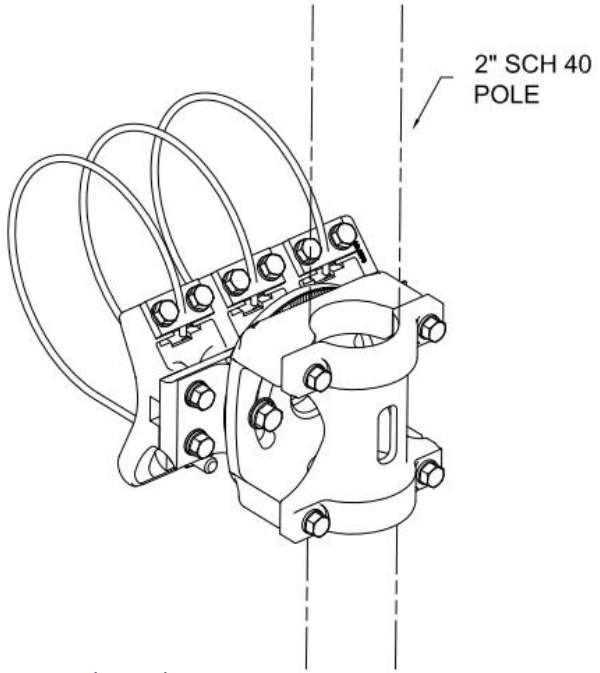
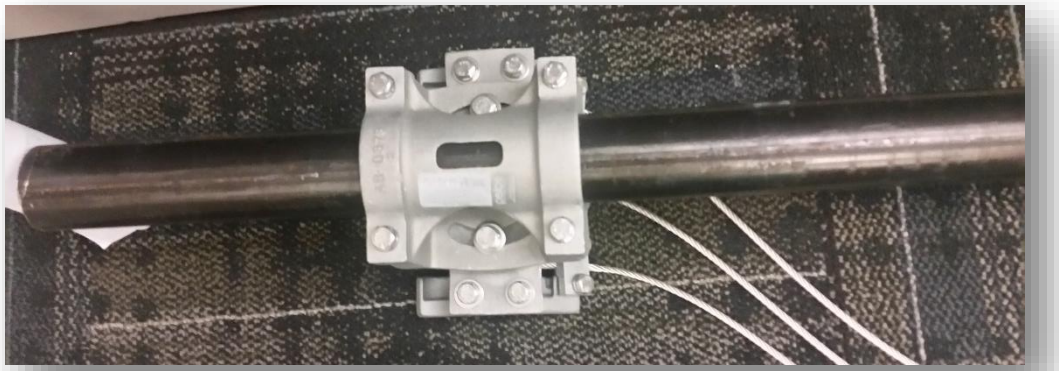


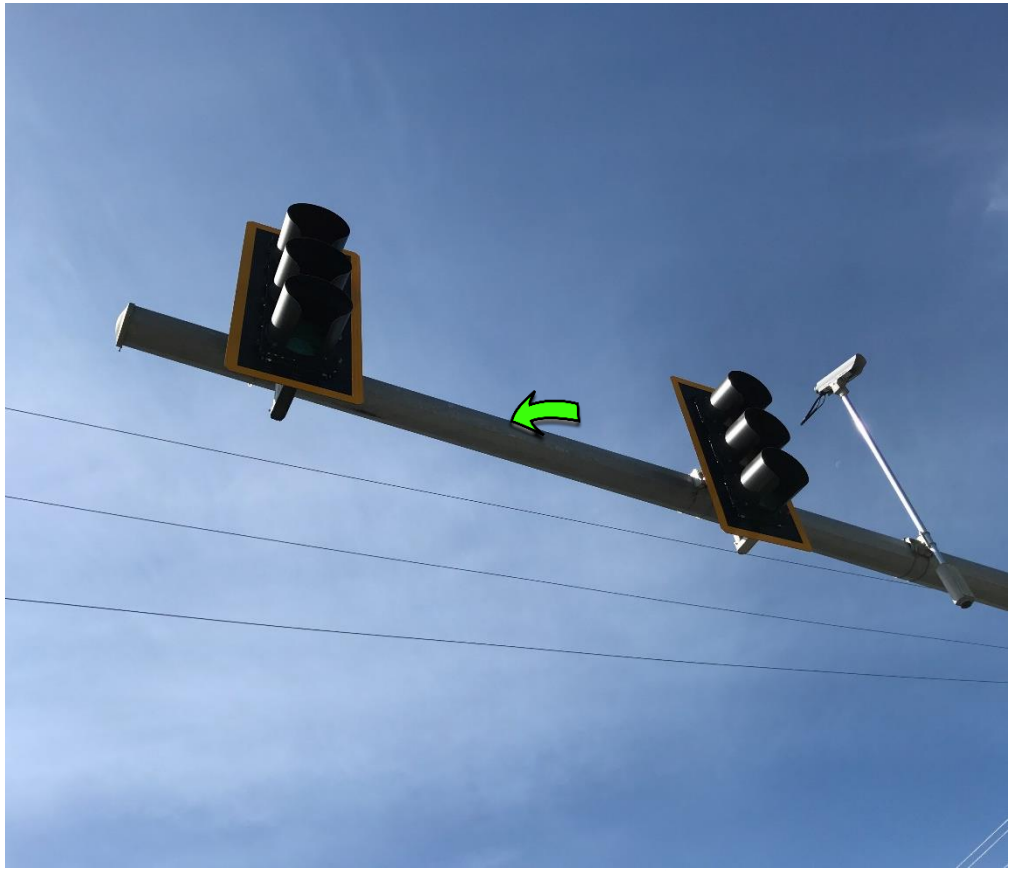
Image: Pelco Products, Inc.
https://www.pelcoinc.com/wp-content/uploads/2016/06/Z-2053-TritonCableMnt.pdf

Fitting the pieces together – Pipe and Bracket



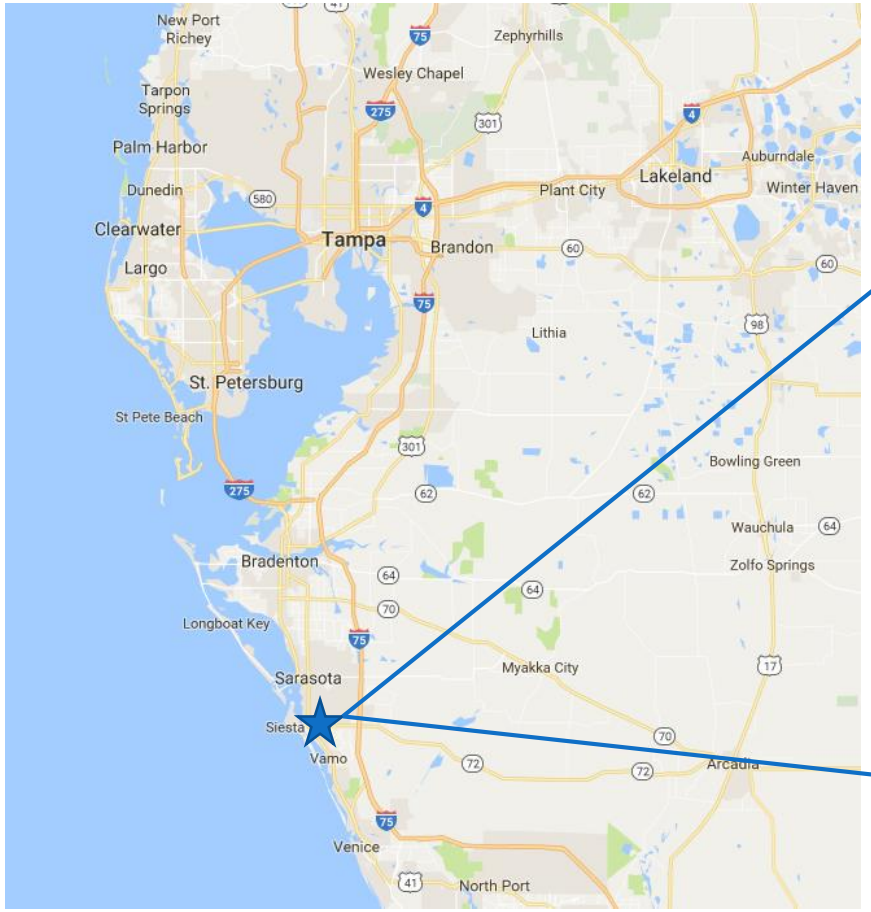
Construction Concerns

Mast Arm Rotating – No, Bolt is present



Signal Head Location

Test Intersection - US 41 at Club Drive, Sarasota County



Source: Google Earth 2017

Pelican Plaza Shopping Center
8308 S Tamiami Trail, Sarasota, FL 34238

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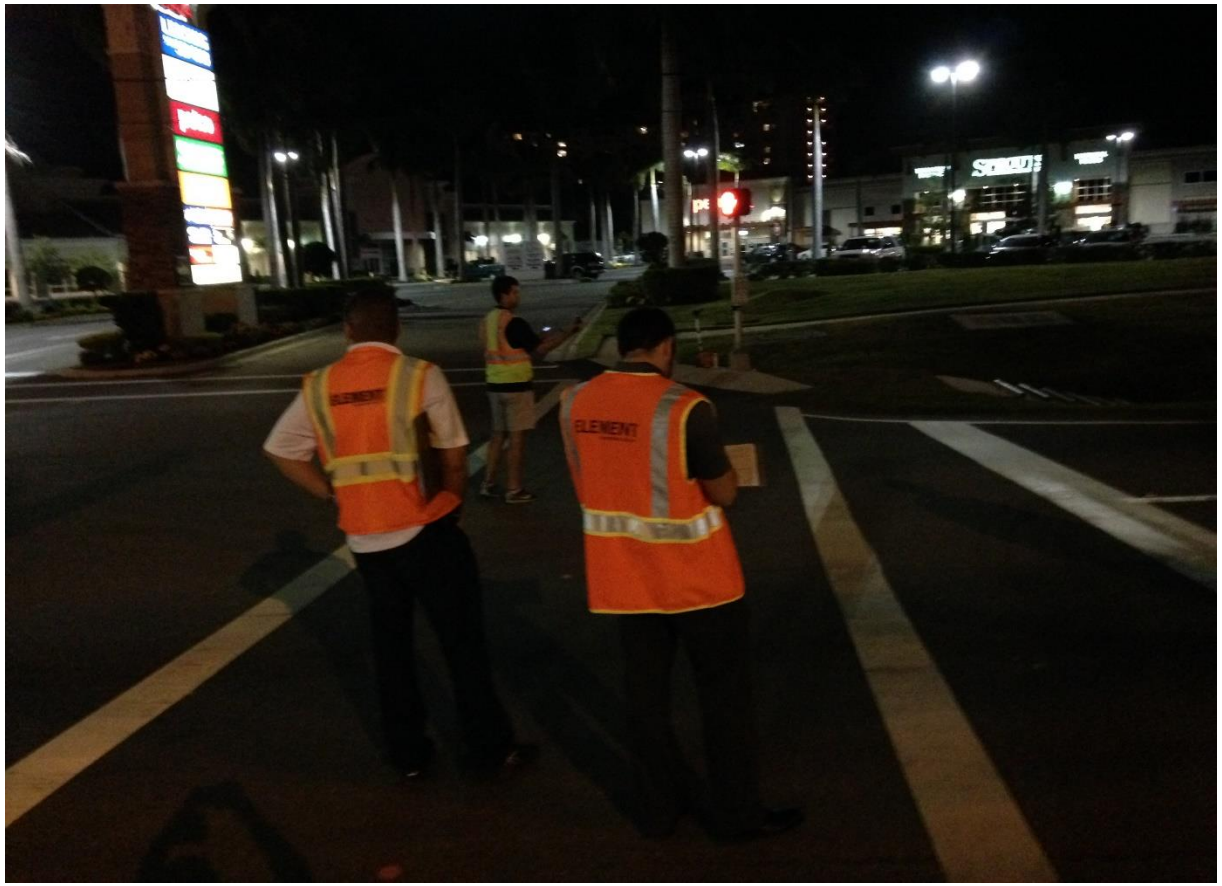
Existing Conditions

- Rural four lane divided highway
- 45 mph speed limit
- Conventional HPS lighting on 50-ft poles on the east side.
- No intersection lighting
- Mast arm in each quadrant

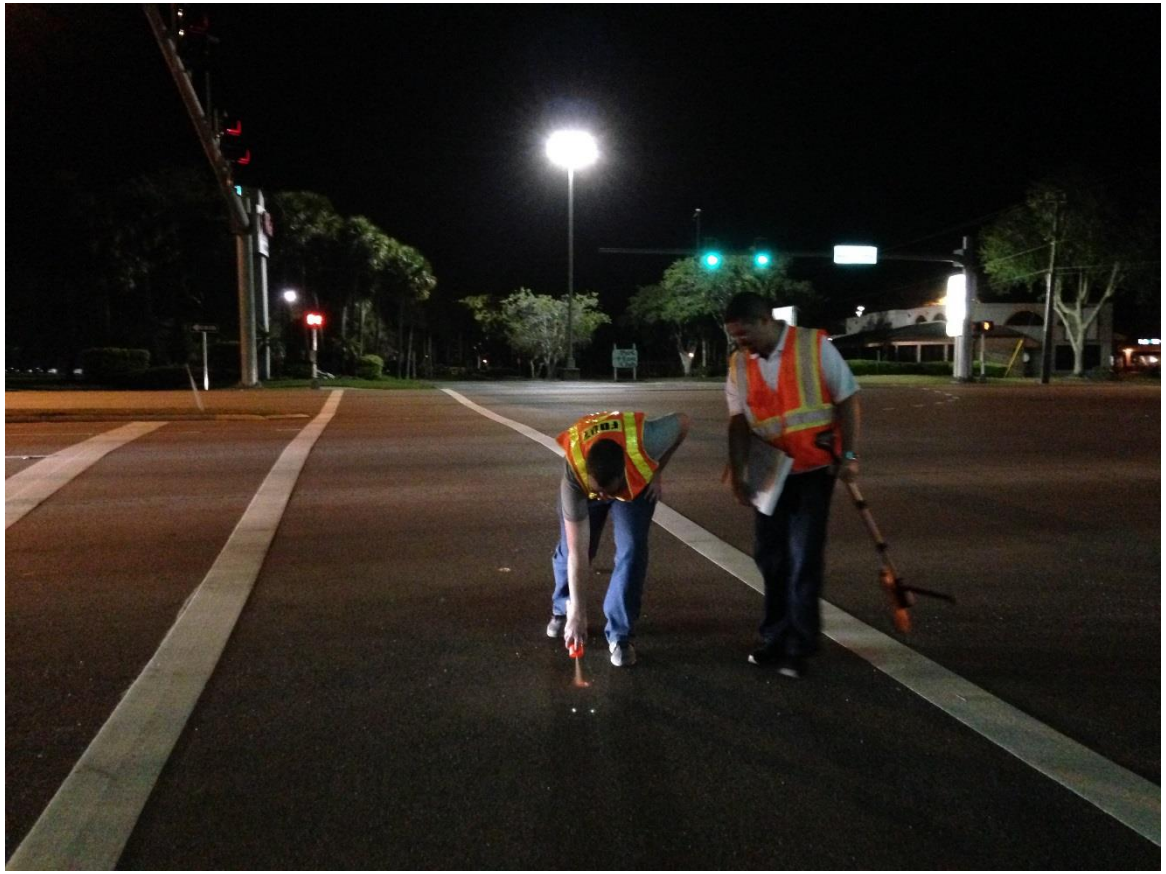
Existing Conditions



Northwest corner of the intersection

Data Collection

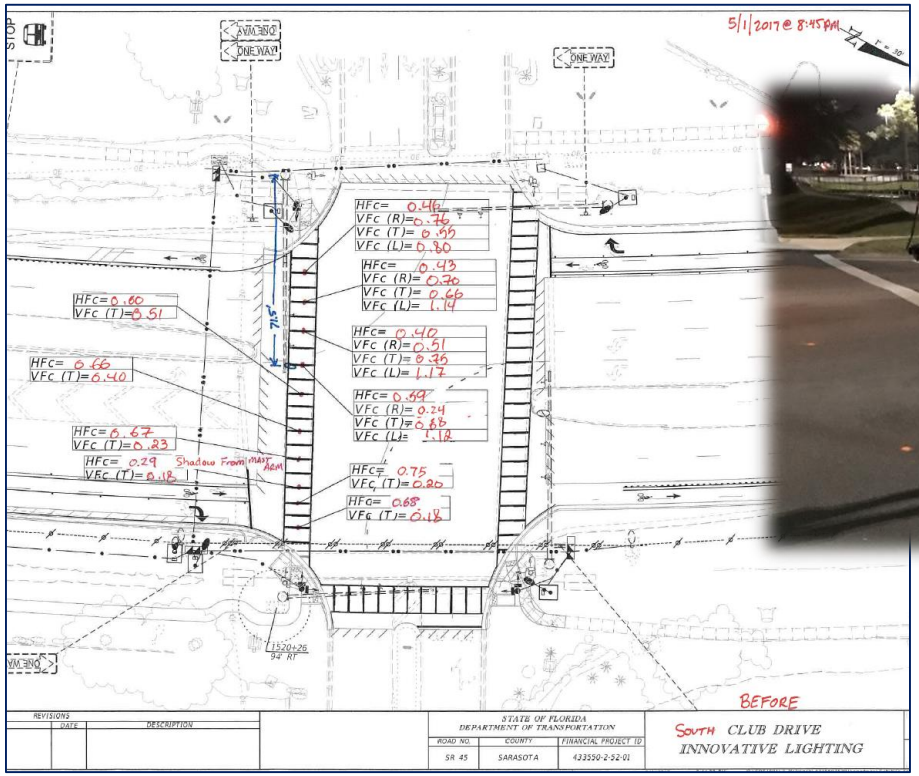
Measuring Light Levels – Data Collection

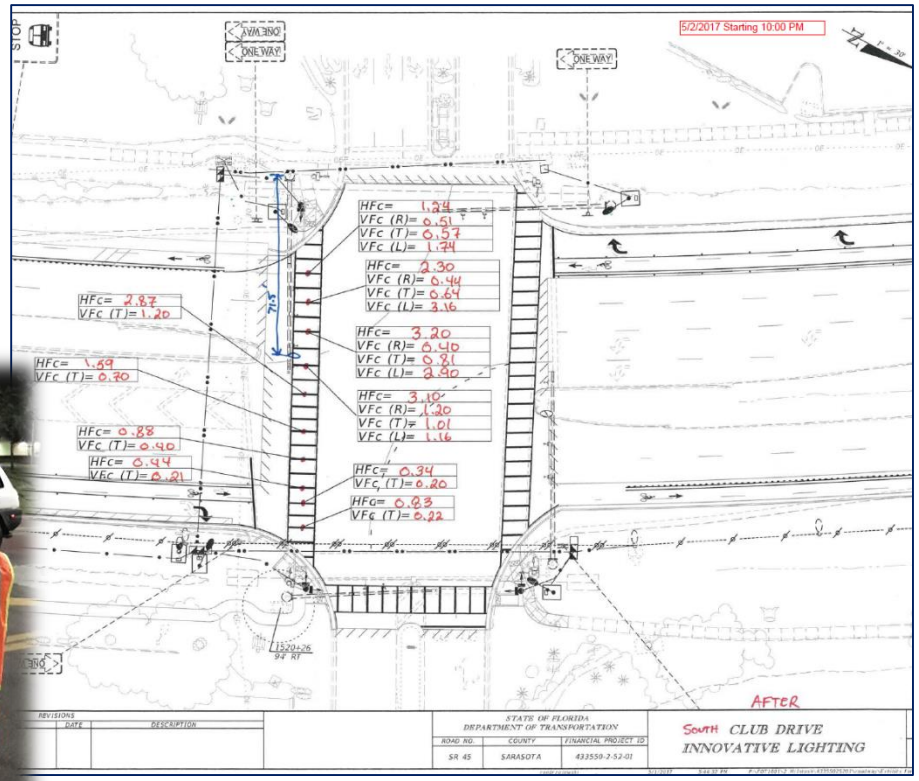


Painted Orange Dots

Measuring Light Levels –Data Collection

Before





After

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Installation

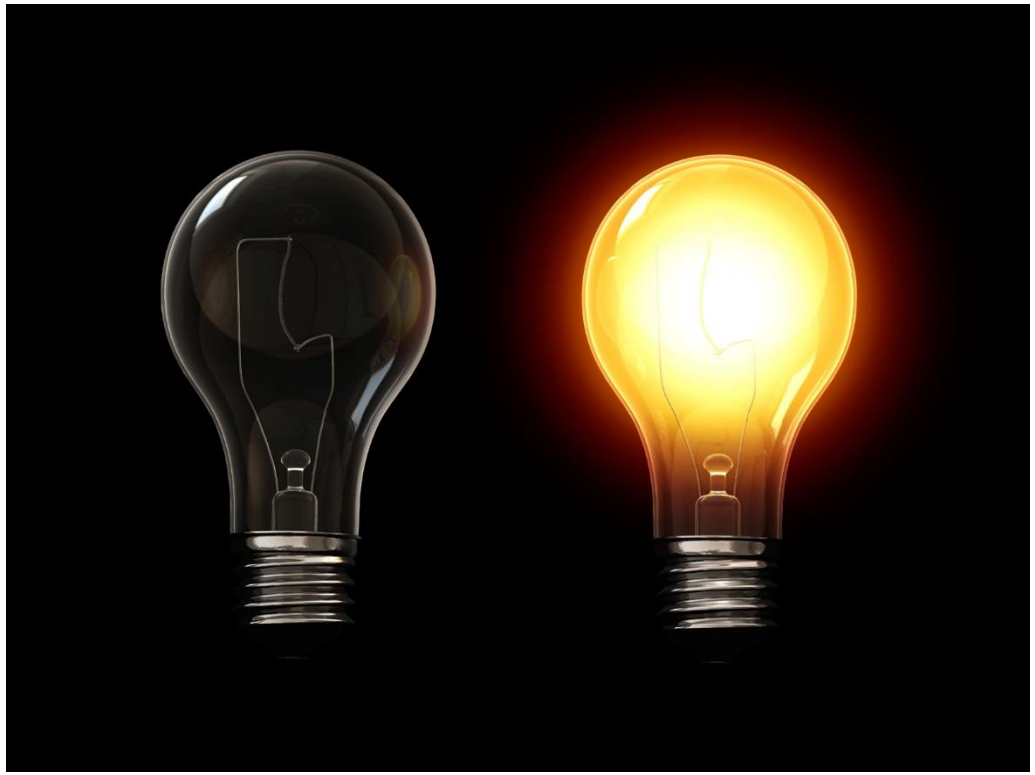
Installation

Install Mast Arm Bracket

Insert Pipe and Mount Luminaire

Installation

Big Reveal!



Let’s see how it looks….

COMPARISON VIDEOS

After Installed on all 4 Mast Arms – Facing South

Comparison Video –
Before & After Pelican Plaza Driveway

After Installed on all 4 Mast Arms – Facing North

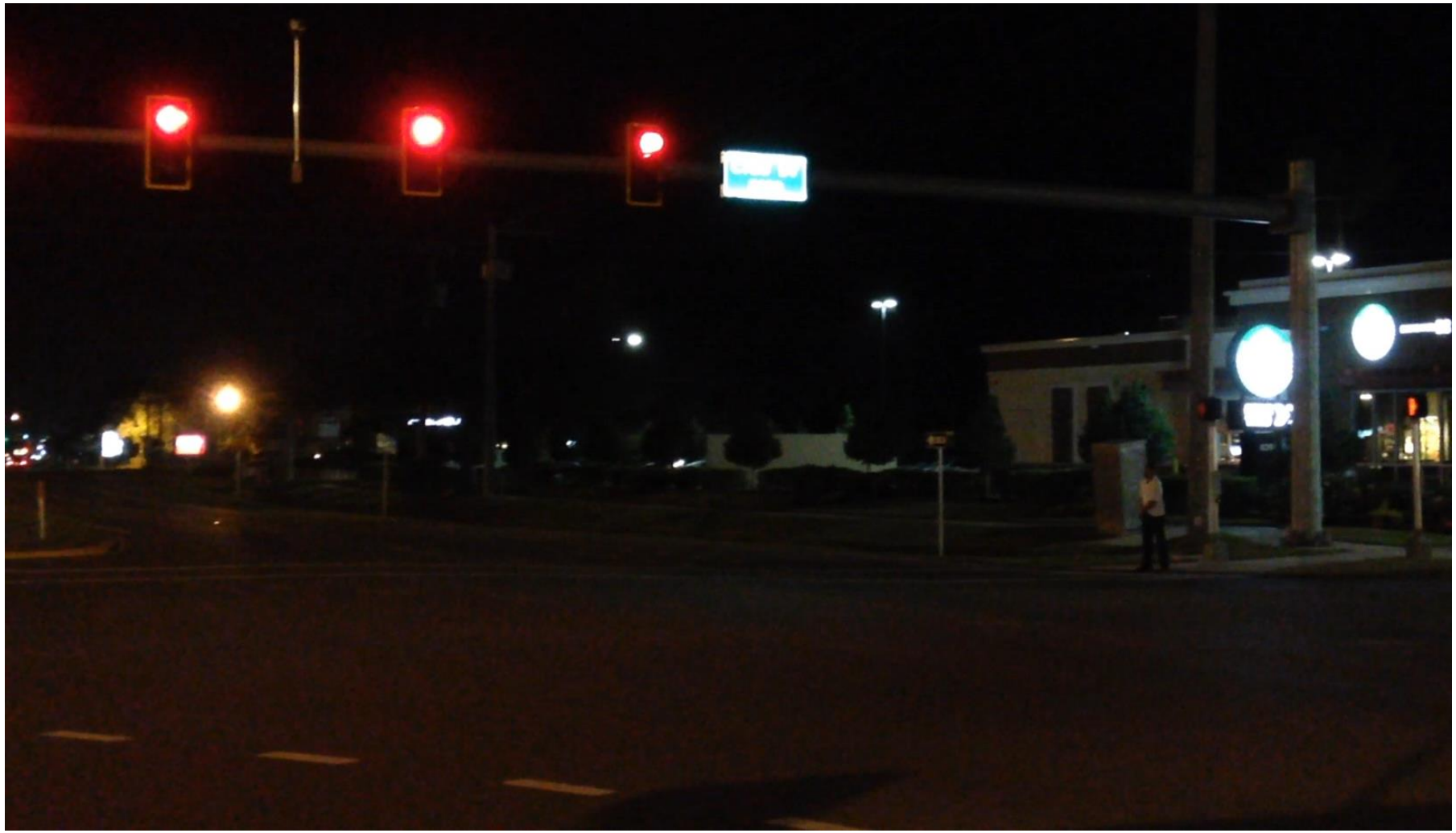
COMPARISON VIDEOS - Walking

Before with Dark Clothes (West Leg)

COMPARISON VIDEOS - Walking

After with Dark Clothes (West Leg)

COMPARISON VIDEOS - Walking

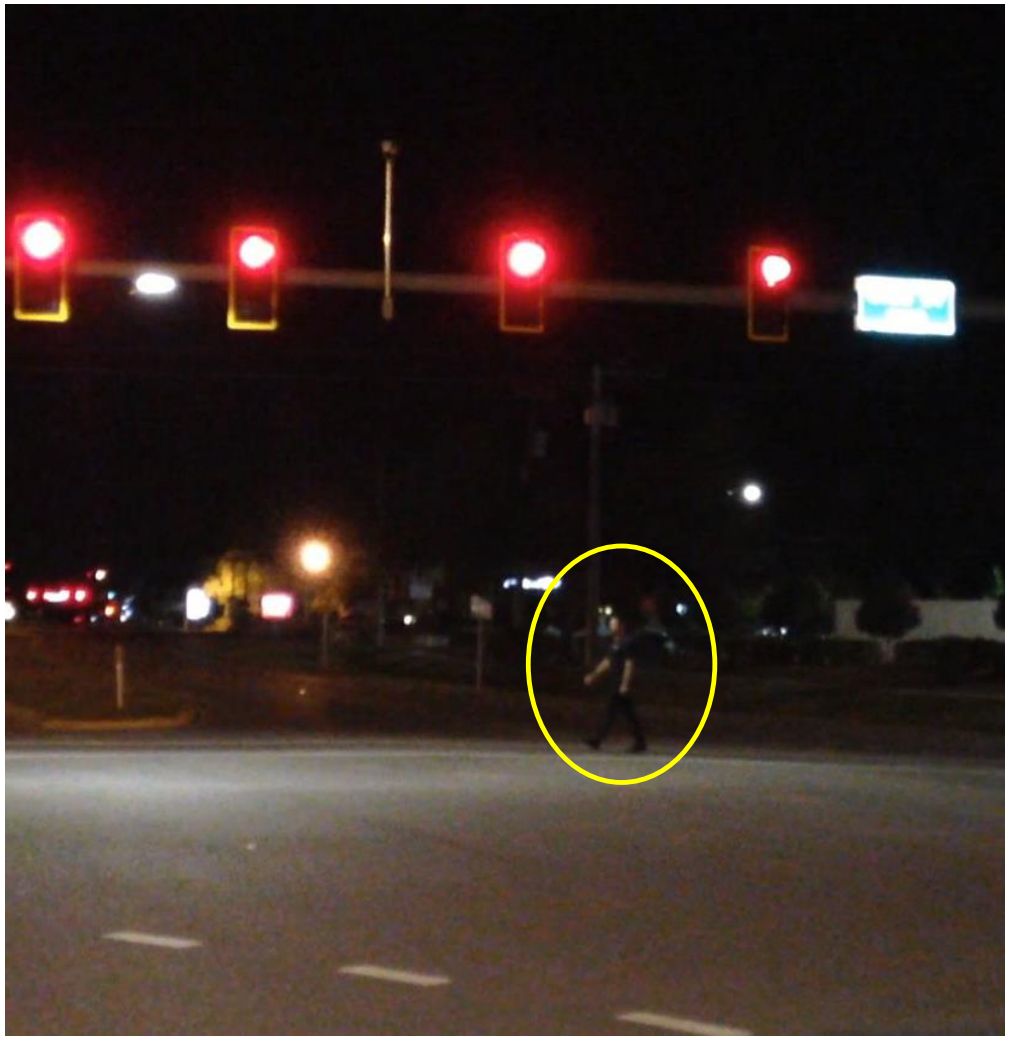


Before with Light Clothes (South Leg)

COMPARISON VIDEOS - Walking

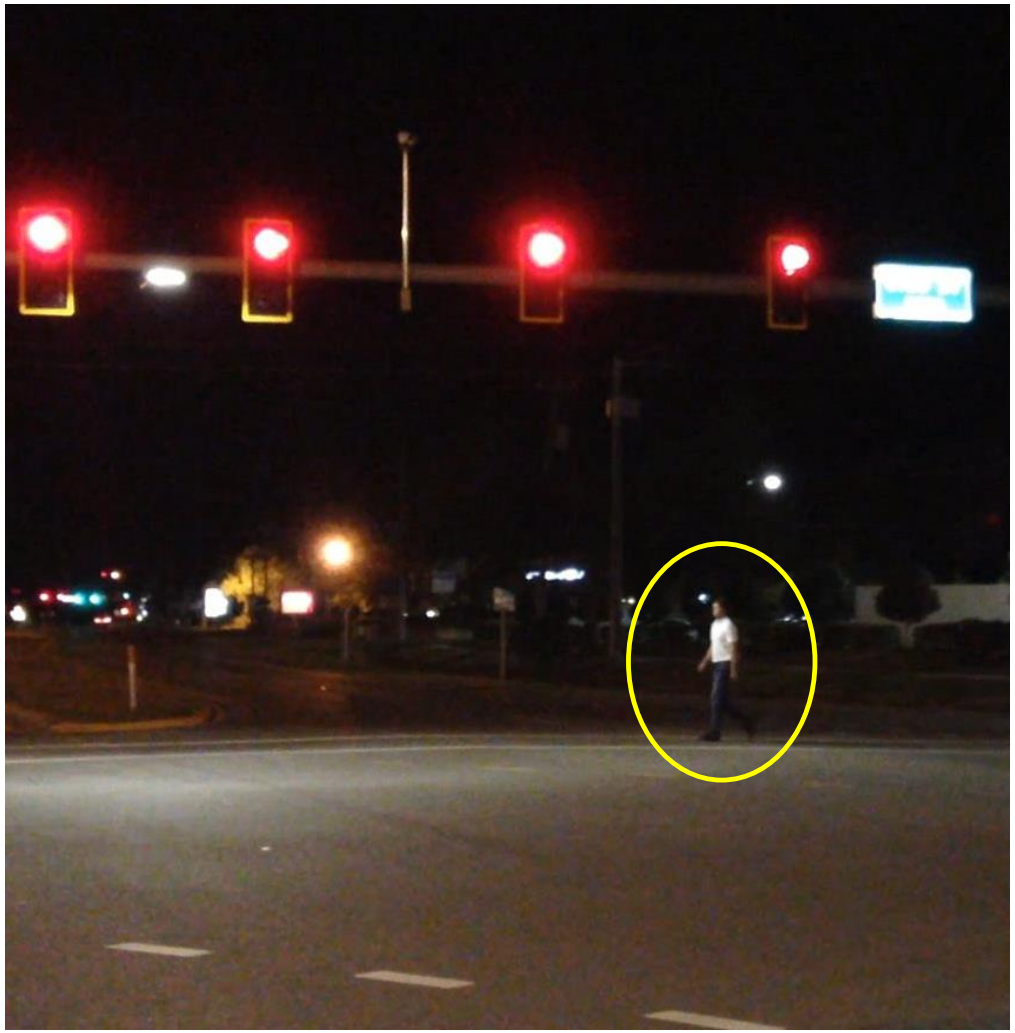
After with Light Clothes (South Leg)

COMPARISON PHOTOS - Walking



Before and After with Dark Clothes (South Leg)

COMPARISON PHOTOS - Walking

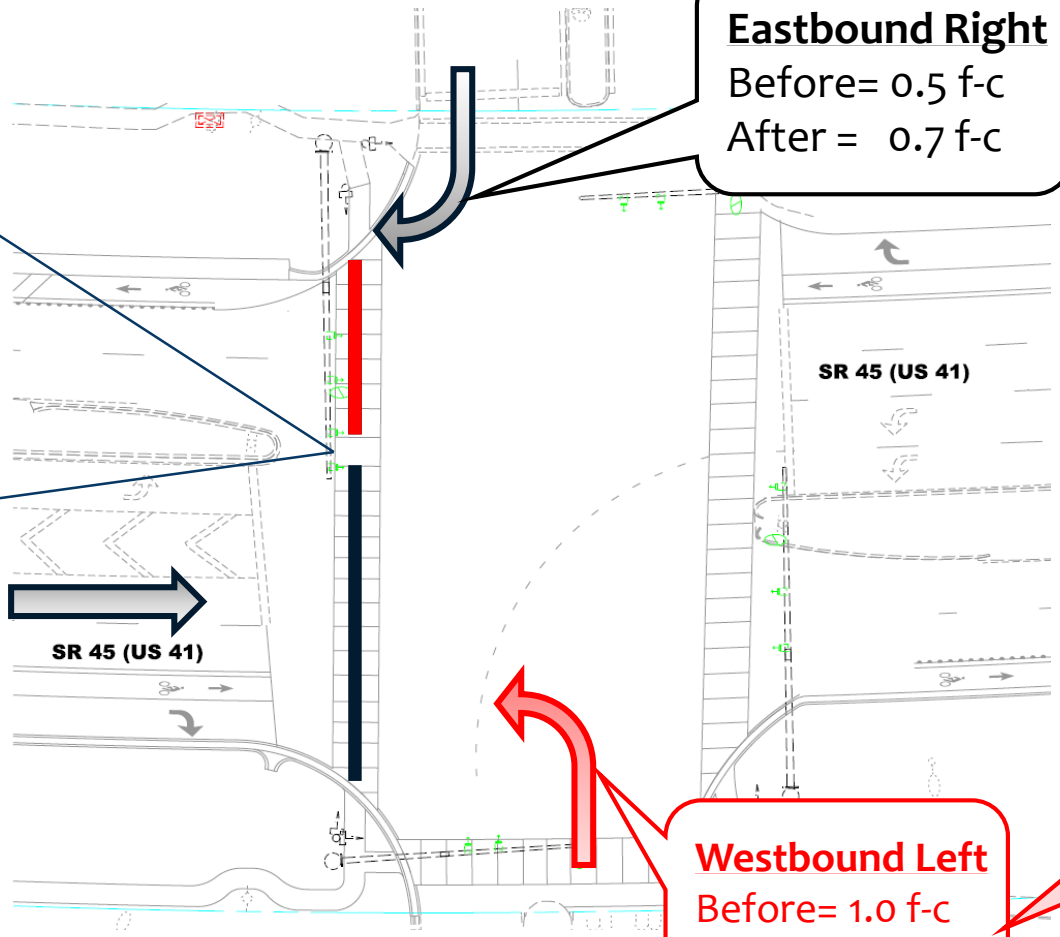


Before and After with Light Clothes (South Leg)

Before and After Light Levels

Vertical Illumination – Before/After

South Crosswalk



Eastbound Right
Before= 0.5 f-c
After = 0.7 f-c

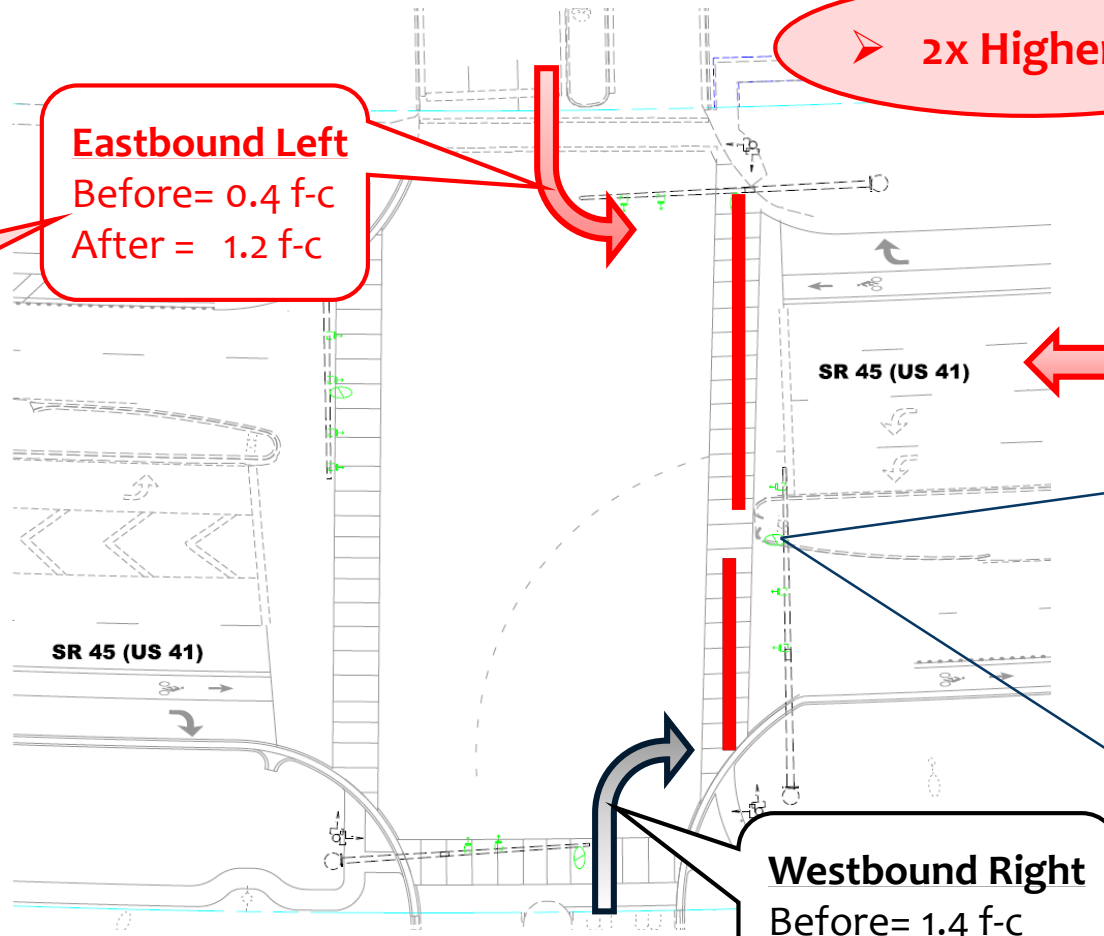
Northbound Thru
Before= 0.3 f-c
After = 0.5 f-c

Westbound Left
Before= 1.0 f-c
After = 2.6 f-c

- 2x Higher
- Now meets PPM Criteria (2.3 f-c)

Vertical Illumination – Before/After

North Crosswalk



Eastbound Left
Before= 0.4 f-c
After = 1.2 f-c

➢ **3x Higher**

➢ **2x Higher**

Southbound Thru
Before= 0.6 f-c
After = 1.4 f-c

Westbound Right
Before= 1.4 f-c
After = 1.6 f-c

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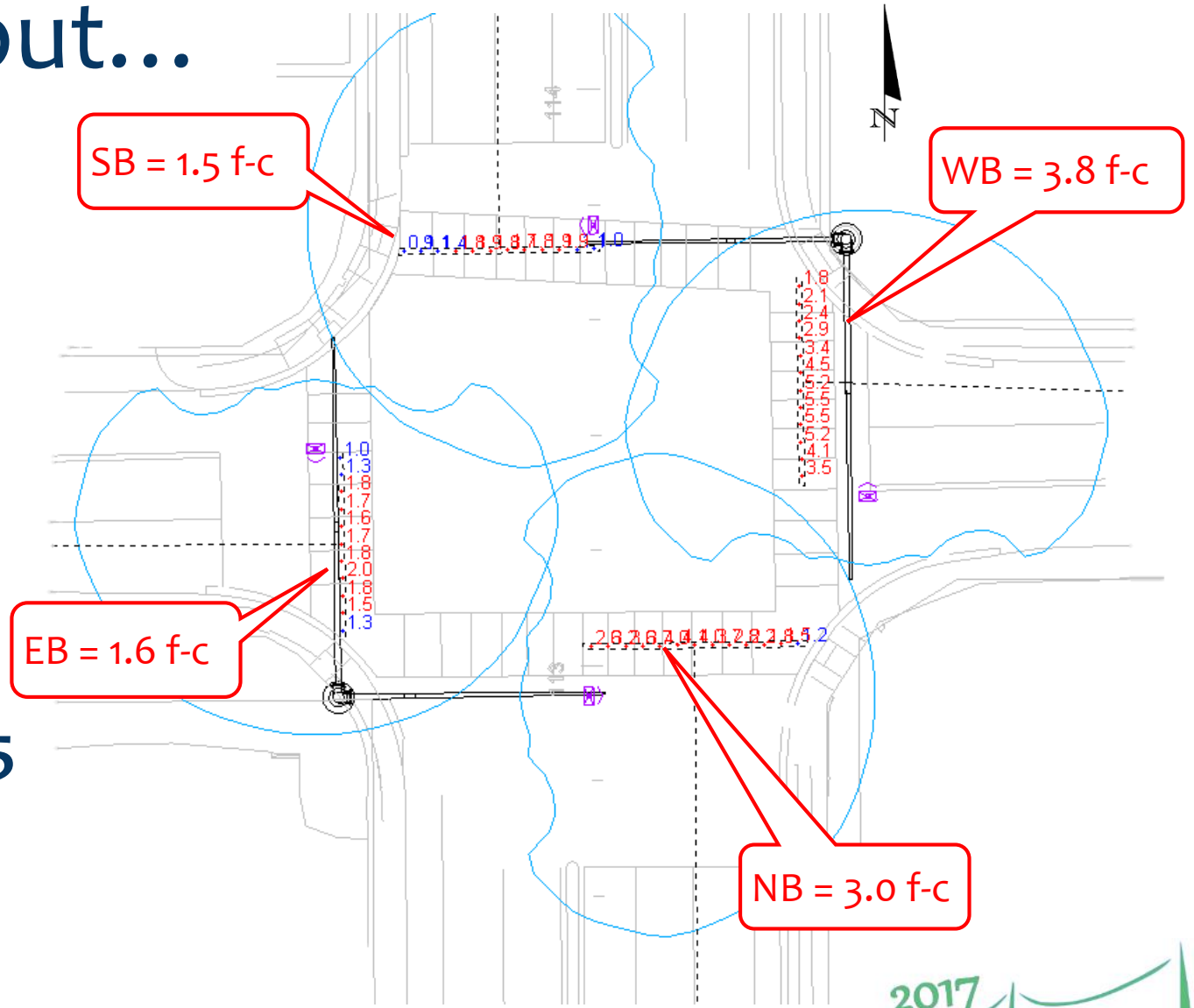
Did It Work? Yes, but…

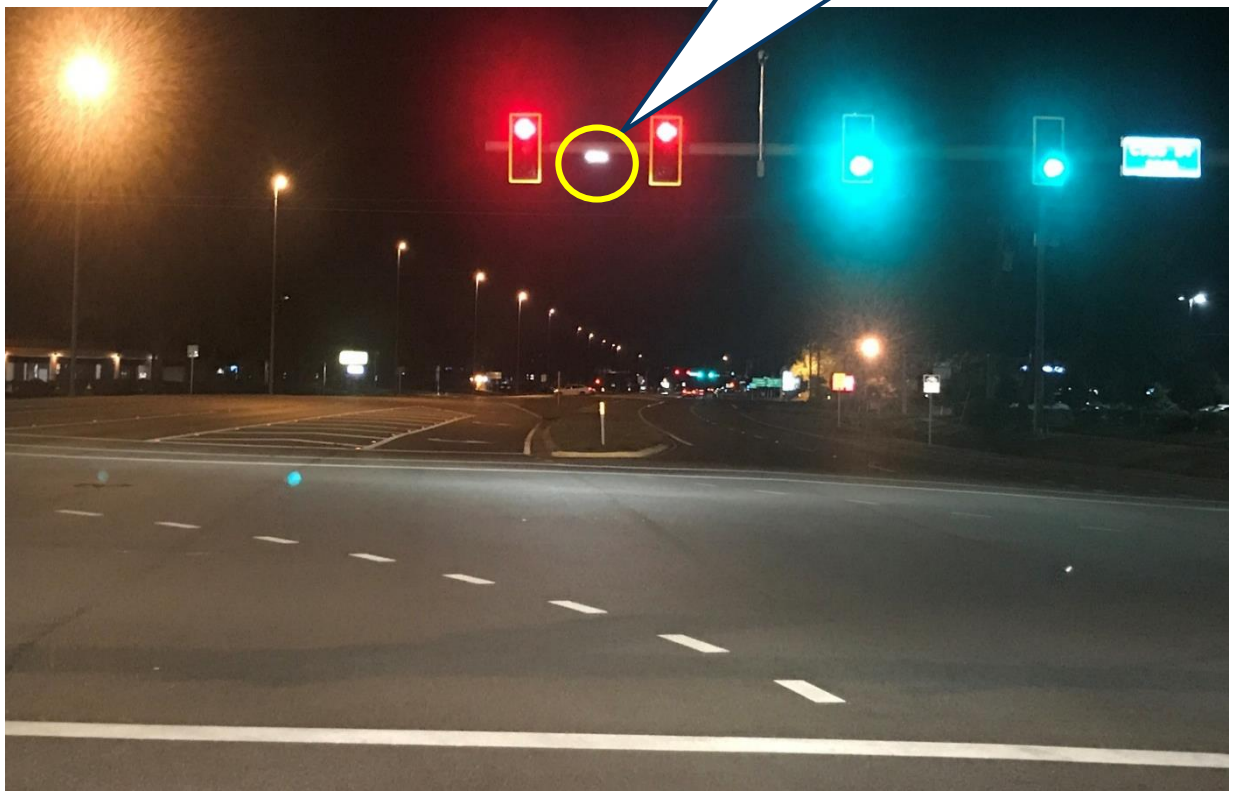
- Still in test phase
- Mast arm and crosswalk placement is key
- Supplement, not replacement, to standard light poles
- **Meets Retrofit Criteria (1.5 f-c) using only 4 mast arm mounted luminaires**

Sample Exist. 4-Lane Urban Intersection



Field Test Questions/Concerns

- Does it light the Crosswalk?
  - **YES**
    - General concurrence during field observations
    - *Big Reveal* video
- Too bright or distracting?
  - **NO**
    - General concurrence during vehicle test runs
    - Picture of luminaire between signal heads



Looking south from the stop bar

Ultimate Goal

- ✓ Increase pedestrian visibility at night in crosswalks
- ? Reduce nighttime crashes
- ✓ Additional option for analysis
  - **Light the un-lightable**
- ✓ Provide a supplement for conventional lighting
- ✓ Create a cost-effective solution

Where do we go from here?

- Prepare a feasibility report
- Meet with District and Central Office staff to discuss findings
- Prepare for eventual developmental implementation
  - Specifications
  - Standards
- Look to incorporate this concept within the US 41 projects.
  - Utilize a Technical Special Provision

Coordination

Coordination & Special Thanks

- Partnerships
  - FDOT - District One and Central Office Leadership
    - District Structures
    - Manatee Operations Center
      - Maintenance of Traffic via Acme Barricades (Contract)
  - Sarasota County
    - Traffic Operations
    - B & E Signal & Lighting, Inc. (Contractor)
    - Maintenance
  - Element Engineering Group
  - ICON Consultant Group
  - Fixtures donated by DOT Lighting and Current, Powered by GE

Questions?

Project Questions:

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